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SUGGESTIONS FOR FOREST PLANTING ON THE SEMI-ARID PLAINS.

THE REGION.

The suggestions for forest planting contained in this circular apply to the western portions of Kansas, Nebraska, and Oklahoma, northwestern Texas, eastern Colorado, and eastern New Mexico. The climate of the region is semiarid. Although the average annual precipitation is sufficient for the production of certain agricultural crops, the distribution of the rainfall is uneven, and wide areas often suffer from prolonged drought.

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ADVISABILITY OF TREE PLANTING.

The entire region is practically treeless. Here and there, of course, trees have been planted, but forest planting has in no way kept pace with agricultural development.

It is a generally accepted fact that the best agricultural conditions exist when from 10 to 25 per cent of the land is in forest. While there is no probability that so large a proportion will ever be attained on the plains, there is real need for a certain amount of forest growth upon them. By a careful selection of species, the choice of suitable sites, and proper management of plantations enough forest can be grown to exercise a marked effect upon farm and ranch development and to supply wood for many domestic purposes.

Trees of any species adapted to local conditions of soil and climate can be grown under irrigation. Likewise land which has water within 15 or 20 feet of the surface, without intervening rock strata, is suitable for tree growth. Where the level of the ground water is much lower and conditions are more arid greater care is required to insure success. Of this type of land the sand hills of western Nebraska and Kansas are best for tree planting. On the high plains to the southwest of this region the chief factor of success, in addition to the care given the plantation, is the selection of the planting site.

For planting on the upland, where conditions are relatively unfavorable, the best trees are honey locust, Russian mulberry, Osage orange, and red cedar. Next in hardiness to these are black locust, white elm, green ash, and hackberry, and in the north Scotch pine, Austrian pine, western yellow pine, and jack pine. All of these species are also suitable for planting in valleys and on irrigated land. In addition to the species mentioned, cottonwood, boxelder, and hardy catalpa are adapted to moist sites.

There are a number of other species which have proven to be more or less adapted to the plains and which may be planted in selected situations for sake of variety. These are: Black walnut, coffeetree, silver maple, ailanthus, wild china, Mexican walnut, bur oak, white poplar, Lombardy poplar, Russian olive, Chinese arborvitæ, blue spruce, and sycamore.

PROTECTIVE PLANTING.

A windbreak consists of a few rows of trees planted primarily for the purpose of checking the force of the wind. The term "shelterbelt" is applied to larger groups of trees which form forest conditions and serve a protective purpose. Any of the species which are best adapted to the region may be used for windbreaks. Where evergreens will succeed, however, they are more desirable, since they

afford better winter protection than deciduous trees. Within their planting ranges the Austrian pine and Scotch pine make comparatively rapid growth and serve the purpose well.

A windbreak consisting of a single row, to be effective, should be composed of a densely growing species which branches close to the ground. For low breaks of this character the Russian mulberry and Osage orange are excellent. The cottonwood is often used for windbreaks in the valleys.

The primary utility of windbreaks is to shelter an orchard or a residence site, to prevent hot winds from scorching the field crops, and to conserve soil moisture within the protected area. They may also be planted about open pastures for the protection of stock. Incidentally, the windbreak may furnish useful material, but it should be placed along the sides of fields and buildings where it will afford the most effective protection.

WOODLOTS.

Wherever agriculture is practiced in the plains region, the farmer will find it profitable to devote a few acres of good land to trees. It is true that some time must elapse before the plantation will become productive, but by the choice of rapid growing species and by close spacing the thinnings which will be necessary in a few years will provide material suitable for fuel, stakes, and the like.

The choice of species is limited and will depend somewhat on the location. Trees that grow rapidly and at the same time produce wood of good quality are best. If they also sprout from the stumps, the forest may be made permanent with a little care. Where it succeeds, black locust combines these desirable qualities in the highest degree. Other species which are useful in woodlot planting are Osage orange, Russian mulberry, honey locust, green ash, and hardy catalpa. The range of catalpa is more restricted than that of the other species.

A judicious mixture of species is often advantageous. Differences in habits of growth and ability to withstand shade can thus be made to aid in the development of well-formed trees. At the same time the owner can have both fast and slow growing trees and a wider choice of timber for different needs.

SHADE TREES.

For street and roadside planting the most suitable trees are honey locust, green ash, white elm, hackberry, and, in the North, Austrian pine. Street or road plantings should not be mixed; a single row of trees looks better when it contains but one species.

METHODS OF PLANTING.

The best method of establishing a forest plantation is by the use of nursery stock. Evergreens should be purchased from a commercial nursery. It is often practicable, however, to raise hardwood species in a home nursery. Advice in regard to nursery practice is given in Extract 376 of the Yearbook of the Department of Agriculture, which can be had upon application to the Forester.

Before the trees are set the ground should be worked thoroughly and put in good condition. Where virgin sod exists it should be broken and the land farmed for two or three years. Deep plowing, followed immediately by the harrow, saves moisture and makes the soil easily penetrable by the roots.

Trees should be handled with the least possible exposure of the roots, since the rootlets will dry out if exposed to the air for even a short time. The roots of conifers are especially sensitive. If seedlings are received from a distance, they should be unpacked at once and their roots dipped into a pail containing a thin mud. After this the tree should be "heeled in" according to the following method:

Dig a trench about 18 inches or 2 feet wide, and deep enough to bury the roots and part of the stems. The trench should run east and west, with its south bank somewhat sloping. A layer of trees should be placed in the trench on its sloping side, their tops toward the south, and their roots and stems covered 2 or 3 inches deep with fresh earth dug from the opposite side of the trench. A second layer of trees should then be put in and covered as before and the process repeated until all the trees have been heeled in.

With conifers care should be taken not to bury the foliage and either to choose a shady place for the young trees or to construct a shade over them with brush or laths.

The best time to plant young trees is just before growth begins in the spring, when the seedlings are likely to receive the least injury. In general, planting should be done as soon as possible after the frost is out of the ground. The exact period will depend upon local climate and soil conditions.

In planting, the seedlings should be carried roots downward in a pail containing several inches of water. The seedlings should be set in furrows or in rows marked with a lister. In the latter case a spade or mattock may be use for opening the holes. The width and depth of the hole depends on the character and size of the plant's root system. It is of the greatest importance to press the earth firmly about the roots, so that all the air spaces are filled. The soil should

not be packed so hard, however, as to be impervious to water, and it is desirable to leave a slight depression around the collar of the plant in order to collect any moisture that may fall.

CULTIVATION AND CARE.

The advantage to be gained by continued cultivation of a forest plantation makes rather wide spacing advisable, even though certain species which have a spreading habit may require pruning. Compensation for the wide spaces between the rows can be secured in large measure by setting the trees closer in the row. The spacing of many plantations is 4 by 4 feet, but trees set in that way can be cultivated only two or three years. Spacing 3 feet by 8 feet makes it possible to continue the cultivation much longer. Species which need more room can be set 6 feet by 6 feet or 4 feet by 8 feet, and as they grow the space required can be obtained by removing the less promising individuals. Without proper conservation of soil moisture trees will neither grow rapidly nor preserve their vigor. On the semiarid plains wide spacing and frequent cultivation will produce better trees than close spacing and little cultivation.

Successful forest planting on the plains, where the rainfall is light or irregular and the evaporation great, depends largely upon the proper tillage of the soil. It is generally believed that no kind of forest trees can be grown successfully on the high table-lands of the southern portion of this region without irrigation. There is no doubt that irrigation is necessary to grow trees from seed in a forest nursery, but in plantations good tillage will usually suffice.

The early tree planters often set their trees carelessly, and left them to struggle with the native vegetation and dry weather. Planters now realize that trees as well as agricultural crops respond to good cultivation. The object of cultivation is twofold: First, to conserve the soil moisture; second, to prevent the growth of weeds and grass. The natural supply of moisture on the plains is sufficient for the growth of many species of trees, provided it is fully utilized and not allowed to escape through evaporation or to be appropriated by weeds and grass.

Cultivation should not be continued too late in the fall, since it unduly prolongs the growth of tender young shoots which are unable to withstand the early frosts. Except on irrigated land or on sites where the ground water is near the surface, the planting of field crops between rows of young trees is unwise, since the trees need all the available moisture. The best implements for the cultivation of the ground are the pulverizing harrow, the disk harrow, the dagger-tooth harrow, and the five-tooth cultivator. The plow should never be used

in cultivating the plantation. Care should always be taken not to injure the stems of the trees in any way.

Grazing animals should be rigorously excluded from all plantations. Even if the trees are too large to be broken off by the stock, every branch within reach will be browsed, and the desirable forest conditions of shade, undergrowth, and litter will be destroyed. In a well-established grove stock may do little harm, but not until the crowns are entirely out of reach should the cattle be admitted. Even then injury may result from trampling of the soil; a heavy soil becomes packed so that it is nearly impervious to water, and a sandy one is worn and blown away, leaving the tree roots exposed.

Every forest plantation should be protected from fire. Where conditions permit, a very satisfactory fire guard is made by plowing two or three furrows about the plantation close to the trees, and then making a second series of furrows from one to two rods outside the first. These lines may be kept free from vegetation by replowing each year, or they may be used for crops that do not easily burn. The space between the two series of furrows should be kept free of all combustible material by burning it over at safe times.

Plantations should be carefully watched to detect the presence of injurious insects. Insect damage should be reported promptly to the Bureau of Entomology of the United States Department of Agriculture, which will identify specimens sent and suggest measures for their control

TREES FOR PLANTING.

RUSSIAN MULBERRY (*Morus alba tatarica*).

Russian mulberry should be planted only in the southern portions of the plains. It can not endure the severe winters of the region to the north. The characteristic form of the tree is low and bushy, and while its growth is comparatively rapid it will not produce large-sized material. If planted close and severely pruned, it will produce good fence posts and fuel. On favorable sites posts can be cut in from 10 to 15 years. If left unpruned the natural form of the tree makes it suitable for low, dense windbreaks.

The leaves of the Russian mulberry form an excellent food for silkworms (*Bombyx mori*). The quality of the leaf for feeding purposes is fully as good as that of the broad-leafed varieties, but its much divided form makes the labor of feeding somewhat greater. The Bureau of Entomology has been for several years past distributing mulberry seedlings in connection with silk-culture investigations.

Russian mulberry will grow on both sandy and clay soils, but does best on rich loamy soil where water is from 10 to 15 feet below the

surface. It will endure a considerable amount of drought and neglect. Even in dry situations its growth is fairly rapid. These qualities adapt it to both upland and valley situations. It is decidedly tolerant of shade and can therefore be used for underplanting or for mixing with more rapid-growing species.

One-year-old seedlings are best for planting. They should be set 4 feet by 4 feet or 6 feet by 4 feet apart. This close spacing will, to some extent, overcome the tendency to form a crooked stem. For windbreaks one or two rows of trees may be planted at 2 or 3 foot intervals. Russian mulberry may be planted in mixture with black locust, honey locust, and green ash.

OSAGE ORANGE (*Toxylon pomiferum*).

Osage orange is a tree of medium size, with a short trunk and wide-spreading branches. It may be planted throughout the plains region, with the exception of the northern portion, where the trees are likely to winterkill.

The wood of Osage orange is heavy, tough, hard, and strong, and very durable in contact with the soil. It is used for cabinetwork and in the manufacture of machinery, wagon fellies, and tool handles. Where it attains sufficient size the wood is valuable for cross-ties. The tree is well adapted for hedge planting and has been in use extensively for this purpose. It is also widely used for fence posts, and its planting for this purpose is recommended. In addition to its value for hedge and woodlot planting, Osage orange is one of the most desirable trees for windbreaks.

Osage orange adapts itself to a great variety of soil and climatic conditions and is extremely hardy. It is tolerant of shade and, in consequence, can be planted in mixture with intolerant species, such as black locust, honey locust, and green ash. Height growth is relatively slow after the first few years, and no great height is ever reached. It nearly equals the Russian mulberry in rate of growth, but is not so rapid growing as black locust. On good soil it will produce fence posts in from 12 to 15 years.

Plantations are best established by the use of one-year-old seedlings. The trees should be set close together to overcome as much as possible the tendency toward profuse branching. A spacing of 3 feet by 6 feet or 4 feet by 6 feet will give the best results.

When cut Osage orange sprouts abundantly from the stump. This insures the renewal of the plantation without further expense.

GREEN ASH (*Fraxinus lanceolata*).

Green ash is a tree of comparatively slow growth when planted on upland soils on the plains. Even in the better situations it is never

of rapid growth. Its extreme hardiness, however, makes it one of the most desirable trees for plains planting.

The wood of green ash is hard, heavy, strong, rather coarse-grained, and brittle. It is used in the manufacture of agricultural implements, carriages, and furniture, and although said to be inferior in quality, is often substituted for white ash. It is also used for general farm repair work. The fuel value of the wood is high, but planting for fuel is not advisable if a more rapid-growing tree will succeed. Although the wood is not especially durable it is often used for fence posts. Despite its slow growth the tree is very valuable for windbreaks or for timber production in situations where few other species will survive.

Green ash is alkali resistant to a marked extent, and it will persist and even thrive under adverse conditions of temperature and moisture. On the plains of western Kansas and Nebraska it has survived on abandoned timber claims where nearly all other species have failed.

One-year-old seedlings should be set out in the plantation. Close planting on well-prepared sites is advisable. If planted pure, the spacing should be either 4 by 4 feet or 4 by 6 feet, but if mixed with other trees a spacing of 6 by 6 feet is preferable. Green ash will thrive when planted pure, but will produce better timber if planted in mixture with some other species, such as hackberry. Other desirable associates are white elm and red cedar.

If the object of the plantation is the production of fence posts, pruning is of importance. Careful pruning will increase the clear length and will in this way make the stand consist of a large proportion of first-class post timber.

BLACK LOCUST (*Robinia pseudacacia*).

Black locust (known also as "yellow locust" or often simply "locust") is one of the most desirable trees for economic planting within the region. Although in many regions subject to attacks by injurious insects, it has suffered little damage from this source on the plains. In Oklahoma, particularly, there is no record of the presence of the borers. Locust is a rapid-growing tree, but is relatively short-lived. In good situations it makes an annual height growth of from 2 to 4 feet and a diameter growth of from one-quarter to one-half inch. This rate is sometimes maintained for twenty-five or thirty years, but more frequently the growth becomes slower after the fifteenth or twentieth year. After the fiftieth year growth almost wholly ceases.

The wood of locust is very strong and durable. It is used for fence posts, ribs of vessels, treenails, insulator pins, vehicles, and fuel. The most common use of locust is for fence posts, and it has been

extensively grown for this purpose. Because of the large proportion of heartwood the young wood is almost as durable in the soil as the old. Locust posts under average conditions will last from twenty to twenty-five years.

Black locust grows best on a deep, well-drained, fertile loam, but will grow on any soil except a wet, heavy one. It attains excellent development on limestone formations. It demands light during its entire life, and must be planted on situations where it will not be shaded by weeds or brush while young.

Plantations of locust are best established by the use of 1-year-old seedlings, from 12 to 18 inches high. Since the locust has a wide-spreading root system, it requires plenty of room for proper development. A spacing of 4 feet apart each way is too close, unless very early thinnings can be made and the material used for stakes. It is best to place the trees every 4 feet in rows 6 feet apart, or 3 feet in rows 8 feet apart, since these distances make cultivation easy. Locust thrives in pure stands, but it is often advisable to associate it with trees of value for protective purposes. Suitable species are Russian mulberry, Osage orange, and green ash.

To secure a stem that will make straight posts, poorly formed or double-headed trees may be cut back to the ground two years after planting and but a single stump shoot allowed to grow. A limited amount of pruning two or three years after planting is often advisable. Cultivation for two or three years after planting is essential.

HONEY LOCUST (*Gleditsia triacanthos*).

Honey locust is a rapid-growing tree, which can be planted throughout the plains region. The wood of honey locust is coarse-grained, heavy, hard, strong, and durable in contact with the soil. It is used chiefly for fuel, fence posts, and poles. It is as a living tree, however, that the honey locust serves its most useful purpose, since within its range other species can be grown which are more valuable for their wood, but much less desirable for permanent trees. It is useful for hedge windbreaks, for shelterbelts, and for street and general planting in a naturally treeless region.

Honey locust reaches its greatest size on the deep, rich soils of river bottoms. On gravelly or heavy clay soil it does not grow so well. Soil containing lime is especially favorable. The common soil of the plains, however, is well adapted to it, and it will thrive in western Kansas and Nebraska even where there is little precipitation. It is equaled in drought-resisting powers only by the Russian mulberry and Osage orange, and it will endure severe winters, to which these species would ordinarily succumb. It is very light-

demanding, but has a tendency when not crowded to produce long branches near the ground, which fits it for hedges and windbreaks. Honey locust will also stand cutting back when young, a quality which adds to its value as a hedge tree.

One or two year old seedlings should be used for planting. Usually the most satisfactory spacing is 4 by 6 feet, but in localities where rainfall is light and extensive cultivation is necessary 4 by 8 feet is more desirable, since it renders cultivation easy. If the planter can not give the trees continued cultivation, the seedlings should be planted close together, since it is essential that the trees shall form a complete cover as soon as posible.

COTTONWOOD (*Populus deltoides*).

Cottonwood is a rapid-growing tree and one of the most important species for commercial planting in the Middle West. The timber of cottonwood, though of relatively poor quality, has been used extensively throughout the West, since it matures in a short time in a region usually devoid of other timber. It is used for paper pulp, box boards, backing for veneer, the unexposed parts of furniture, wagon boxes, interior woodwork, and fuel. The fuel value of cottonwood is high, since the tree furnishes a greater amount of wood in a given time than any other species which can be grown in the region. In proportion to volume, however, the relative heat production is low.

Cottonwood is useful for protecting agricultural lands subject to an annual overflow. A narrow belt of trees on the river side of such tracts protects the field from débris and checks the erosive action of the water. It is also well adapted for windbreaks, since by rapid growth it affords protection within a few years after planting.

Plantations of cottonwood require a situation in which the water table is within 15 or 20 feet of the surface, since the most important factor in its growth and development is the available moisture in the soil rather than the fertility. The most favorable site for cottonwood, therefore, is alluvial soil along the water courses. Because of their extensive root systems, individual trees or single rows may thrive on dry upland situations. Planted in rows along highways and fields cottonwood is valuable as a windbreak, and will give good returns in fuel and repair lumber.

Plantations of cottonwood may be established by the use of seedlings or cuttings. Cuttings should be from 18 to 24 inches long, and should be made from 1 or 2 year old branches of vigorous staminate trees, since such trees produce no annoying "cotton." The cuttings should be planted early in the spring, as soon as the frost is out of the ground. Two-thirds of the length of the cutting should be below

the surface of the ground, and on the portion above the surface there should be at least two or three buds. The trees when planted in groves should be planted pure, from 6 to 8 feet apart each way.

WHITE ELM (*Ulmus americana*).

White elm, while not of especially rapid growth, is well adapted to planting on the plains. It is a deep-rooted tree of great hardiness, and is capable of enduring extremes of temperature and moisture. It reaches its best development, however, on deep, fertile, well-drained, alluvial soils.

The wood of white elm is valuable for use in the manufacture of slack cooperage, for flooring, wheel stock, and for the manufacture of agricultural implements. Since it is not durable in contact with the soil it has little value as fence-post timber. The hardiness of the tree and its indifference to soil conditions make it suitable for protective planting, while its graceful, spreading form gives it particular value for ornamental planting.

One-year-old seedlings, from 5 to 10 inches high, should be used in establishing the plantation. The use of older and larger stock is sometimes desirable, but in most cases 1-year-old plants are best for commercial plantations. Where the seedling has formed a long root, this should be cut back to 6 inches and the top pruned correspondingly.

Spacing will vary with local conditions. In general, moderately close planting is best. Six feet apart each way will be satisfactory. In later life the plantation should be thinned to encourage proper development of the remaining trees.

White elm thrives in pure stands, but will also grow well in mixtures. If mixed plantations are established the associated species should be tolerant and of slower growth than white elm. Hackberry is well suited for this purpose.

HACKBERRY (*Celtis occidentalis*).

Hackberry is not a commercially important tree, but throughout this region it may be planted as a shade tree and, in mixture with other species, for windbreaks. The low economic value of its wood, except for fuel, makes its use inadvisable where better trees can be grown. It is an excellent shade tree and rivals the white elm in many of the western cities.

Hackberry will, of course, thrive better on a fertile soil than on a poor one, but its ability to thrive on almost sterile soils is one of its best qualities. It is characteristic of hackberry to live and bear seed in situations where almost any other tree would die. It thrives best

along the water courses, but will not endure swampy soils. A limestone soil seems to be especially favorable. It is tolerant of shade and thrives in mixture.

Two-year-old seedlings are best for planting. The young trees should be set from 4 to 6 feet apart, according to situation and need for cultivation. It may be planted pure or in mixture with such trees as cottonwood, Osage orange, green ash, black locust, honey locust, or white elm.

HARDY CATALPA (*Catalpa speciosa*).

Wherever conditions are favorable, catalpa is one of the most valuable trees for economic planting. Catalpa wood cut from the living tree is almost immune from attack by fungous disease, and is one of the most durable timbers known. When used for fence posts it often remains sound for thirty or forty years.

Hardy catalpa is adapted for planting only in the most favorable portions of the semiarid region. It will thrive on loamy soils in western Kansas in localities where ground water occurs at a depth of from 10 to 20 feet. Unless the roots can reach the water table it is useless to plant catalpa in the plains region, since ordinarily an annual rainfall of at least 25 inches is necessary for its growth. With thorough cultivation, however, it may succeed on loamy soils where the precipitation is from 18 to 20 inches. It will not tolerate a strongly alkaline soil. Hardy catalpa matures early, and under cultivation is one of the most rapid-growing trees planted in the West. Under favorable conditions many trees in a plantation grow to a size suitable for posts in from 10 to 12 years, and the stand becomes merchantable at from 15 to 20 years after planting.

The chief value of the catalpa in the plains region is for posts. There is little profit in planting it except on sites of the first quality, where it will grow rapidly and give early returns. Catalpa plantations should be started with one-year-old seedlings. Because of the severe climatic conditions of the region wide spacing and thorough tillage is advisable. A distance of 4 feet by 8 feet or 6 feet apart, each way, is advisable. While catalpa has thus far been planted chiefly in pure stands, an associate tree of slower growth and greater tolerance may prove desirable. This associate or "filler" would assist in pruning the catalpa and in forcing it into straight upward growth. The Russian mulberry and Osage orange are well adapted to this purpose.

Catalpa requires especial care if the best results are to be secured. Cutting back is advisable during late winter or early spring after one or two seasons' growth in the plantation. During the early part of the following summer all of the sprouts except the most vigorous

one should be removed. The surviving stem should make a straight branchless growth of from 6 to 10 feet the first year. This will largely do away with the necessity of pruning. Protection from the wind should be provided for catalpa plantations by setting out several rows of hardy species along the exposed sides. Two rows of Russian mulberry or Osage orange adjoining the plantation will furnish good protection.

BOXELDER (*Acer negundo*).

Boxelder grows naturally in moist situations throughout most of the region. It can not be recommended for upland planting except in depressions that receive the run-off of surrounding country. It prefers a heavy soil to a sandy one, and is somewhat more drought resistant than cottonwood.

Boxelder is a short-lived tree and rarely attains a large diameter. The wood ranks low as fuel and has little other value. A straight trunk is seldom found. Attacks by borers are frequent, and a leaf-aphis often spoils the appearance of the tree. Under good care it sometimes makes a fairly satisfactory street or lawn tree, but its chief use should be for shelterbelts in the valleys.

In planting boxelder one-year-old seedlings should be used. Since it is a tolerant species, and has a tendency to form a spreading head, the trees should be spaced 5 feet apart each way, or 4 feet by 6 feet. It is rarely desirable to plant boxelder in pure stands except for windbreaks and shelterbelts. In forest plantations the tree may be planted to good advantage as a filler with more valuable species, such as white elm, honey locust, black locust, green ash, and black walnut.

RED CEDAR (*Juniperus virginiana*).

Red cedar may be planted throughout the entire plains region for protection and for the production of fence posts.

The wood of the red cedar is light and soft, with a fine, compact, even grain. Its great durability in contact with the soil makes it especially valuable for posts and poles. The value of red cedar for planting lies in its superior adaptability to the unfavorable soil and climatic conditions of the semiarid region. It develops best in a rather light, loamy soil, containing lime. Few trees, however, exhibit a greater indifference to soils. It will thrive well on dry exposed situations characteristic of this region. Despite its slow growth red cedar is one of the best trees for economic planting on the plains.

Planting this species in the vicinity of orchards should be avoided because the "cedar apple," a fungus very destructive to fruit trees, passes one of its stages on the branches of the red cedar. Three-

year-old transplanted trees are best for establishing a plantation. For pure plantations on dry soils a spacing of 4 feet by 4 feet is advised. On better soils 4 feet by 6 feet or 4 feet by 8 feet is preferable. For windbreaks or shelterbelts on the high prairies of the Southwest a desirable mixture is red cedar and Osage orange or honey locust. Here the trees should be planted 4 feet apart in alternate rows 6 feet apart. Red cedar does well also in mixture with cottonwood. For fence posts cedar should be planted pure, with 4-foot spacing in rows 6 feet apart.

Success with red cedar, especially in the semiarid region, will depend largely upon the character and extent of cultivation given. On unfavorable sites the plantation should be given frequent shallow cultivation for several years after setting. In river and creek valleys, where water is near the surface, it is unnecessary to cultivate after the first two or three years.

PINES.

The four species of pine which have already been given are known to be suitable for planting in only the northern portions of the plains region. None of them is as hardy as red cedar, but their rate of growth is more rapid and compares favorably with that of honey locust. Pines are excellent for shelterbelts and ornamental purposes.

The two foreign species, Scotch pine (*Pinus sylvestris*) and Austrian pine (*Pinus austriaca*), have been planted to some extent in western Kansas, and it is believed that either of them will thrive on the uplands if given proper care. The foliage of the Austrian species is the heavier and darker colored, which makes it both a better windbreak and more ornamental than the Scotch pine.

Jack pine (*Pinus divaricata*) is a very hardy tree and is suited to sterile, sandy soils. It will withstand considerable drought and is rarely injured by frost. Jack pine is intolerant of shade at all ages and not well adapted for mixed plantations. It is one of the most rapid-growing pines, but is comparatively short lived, reaching maturity in about sixty years. Jack pine is well worth a trial throughout western Nebraska, western Kansas, and eastern Colorado. It should prove a good tree for windbreaks, shelterbelts, and farm woodlots, especially in the sand-hill region.

Western yellow pine (*Pinus ponderosa*) is also a hardy species and will endure a great diversity of soil and climate conditions. In the most favorable situations its growth is fairly rapid. On the plains it should be planted in pure stands. Jack pine, western yellow pine, and Scotch pine promise to be the most valuable species in the forestation of the Nebraska sand hills, and by the use of sturdy stock the

range for economic planting can probably be extended over a large part of the plains.

Plantations of any of the pines should be started with three-year-old transplants. These should usually be spaced 4 or 5 feet apart each way. In especially good situations a spacing of 6 feet apart each way is suitable.

Approved.

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *May 21, 1907.*

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